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AURORAL PATCHES SHOWING STRONG HYDROGEN LINES*

L. E. MONTBRIAND AND A. VALLANCE JONES

This note reports the observation with an all-sky camera and high-speed patrol spectrograph of a peculiar auroral cloud or patch from Saskatoon on the night of April 26/27, 1960. While the significance of this observation is not clear, the phenomenon seems to be worth recording since no other similar observation was obtained in a series of 2000 spectrograms. These spectrograms were obtained using an $f/0.71$ transmission grating spectrograph which is fully described by Montbriand and Vallance Jones (1962). This instrument obtained spectra of a strip of the sky along a meridian from north to south by focusing the sky on the slit, which had a spectral width of 30 \AA .

The work of Rees, Belon, and Romick (1961), Montbriand and Vallance Jones (1962), Stoffregen and Derblom (1962), Galperin (1963), and Weissberg (1962) has shown that almost invariably before midnight during an auroral display a band of faint luminosity, resembling a diffuse homogeneous arc and

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exhibiting relatively strong hydrogen lines, moves southward in advance of brighter auroral forms which are weak in hydrogen emission and which lie to the north. Generally, from Saskatoon, during periods of low auroral activity, this zone of strong hydrogen emission showed in the spectra as a clearly distinguishable H_α line at the very northern edge of the spectrogram. On nights when this zone of hydrogen emission moved farther south so that it could be observed visually and photographically, it was seen to take the form of a diffuse homogeneous arc above the northern horizon. Diffuse surfaces or auroral clouds were usually not observed until after the breakup of auroral displays, and hydrogen emissions were very faint or absent.

The spectrograms and all-sky photographs, as shown in Fig. 1, show the appearance of an auroral cloud which crossed the north-south meridian at about 2130 hours at a zenith distance between 20° and 60° south. This peculiar auroral form is clearly visible in the all-sky photographs taken at 2110, 2126, and 2152 hours Mountain Standard Time, and is reflected in a very definite enhancement of the intensity of the $\lambda 4278$ (N_2^+), $\lambda 5577$ [OI], $\lambda 6300$ [OI], and H_α emissions for the spectra recorded between 2118 and 2133 hours and between 2148 and 2203 hours. There is no sign in either the all-sky photographs or the spectrograms of the presence of the cloud at 2233 hours. While the H_α line appears to be strong in the two spectra of the cloud, it does not appear to be abnormally intense, since on the original negative on which it is just possible to pick out the H_β and $\lambda 4709$ N_2^+ bands, the intensity ratio between them is approximately unity, a value frequently observed in homogeneous arcs showing strong hydrogen lines.

In the spectrograms of Fig. 1, it is also possible to see the development of a hydrogen-rich form at the northern horizon and its progression southward. In the last spectrum, obtained between 2218 and 2233 hours, a brighter emission, in which the 1PG N_2 bands, the $\lambda 5577$ line, and the 1NG N_2^+ bands are relatively strong, may be seen just above the northern horizon at a larger zenith distance than the strong H_α line. This sequence is typical of the normal southward progression of the zone of hydrogen emission as outlined above.

In the interpretation of the phenomenon, it may be significant that although conditions were quiet magnetically at the time of the observations there had been a pronounced positive bay between 1600 and 1800 hours during the daylight; this positive bay was accompanied by strong auroral-type absorption of cosmic noise as recorded on a riometer operating at 30 Mc/s. This absorption reached a maximum of 2.9 db by 1745 hours. As twilight faded the auroral patches reported in this note became faintly visible, were intensified for a short time, and subsequently disappeared.

It seems likely that these auroral patches were a remnant of the daytime aurora which occurred just before sunset, but were remarkable in that their spectra showed strong hydrogen lines. The patchy forms which follow auroral breakup usually exhibit little if any hydrogen emission (Omholt 1957; Romick and Elvey 1958; and Montbriand 1961). It is possible that the strength of the hydrogen lines may be related to the geomagnetic latitude and time at which excitation of these forms took place in accordance with the theory of Axford

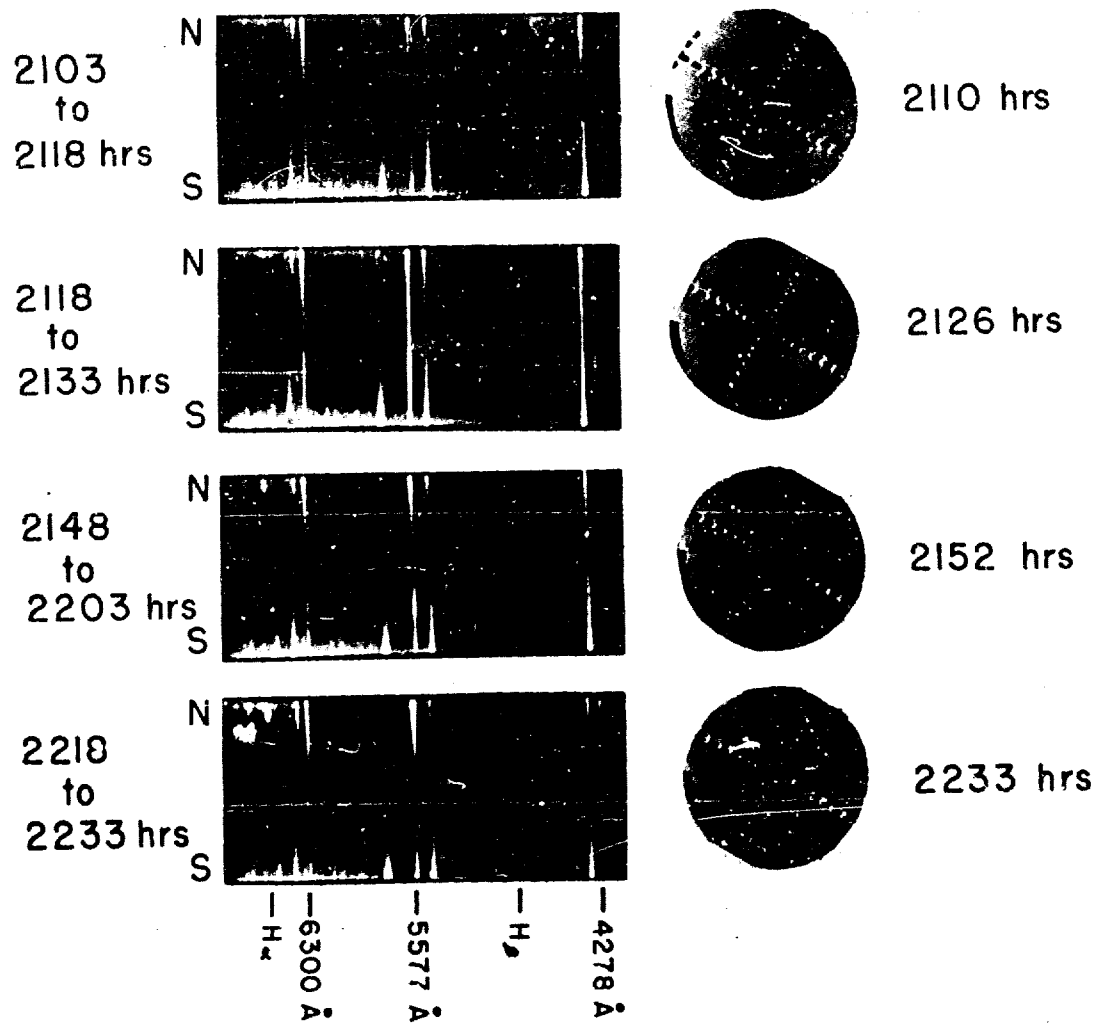


FIG. 1.

and Hines (1961). It may be noted from Fig. 1 that the patch drifted from east to west corresponding to the drift of energetic protons predicted by the theory of Axford and Hines. The height of the auroral cloud must have been relatively low since, as may be seen from Fig. 1, the auroral green line is quite strong in comparison with the red lines in the cloud itself.

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